Performance Analysis of Variable Compression Ratio Engine using Diesel

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Abstract: **An experimental investigation is carried out to study the effect of compression ratio on variable compression ratio engine using diesel oil. In this paper the performance characteristics are studied at various compression ratios and loads. This would give a complete idea how an engine behaves both at various loads and compression ratios. After analyzing an attempt has been made to suggest the best optimal compression ratio at which an engine could work with higher thermal efficiency and lower specific fuel consumption. This detailed study of various engine parameters useful for knowing the best compression ratio of an engine which is found as 17 at which the brake power is 2.662KW at 3/4th load. The Specific fuel consumption is found to be minimum at compression ratio 18.The optimum performance of the engine at a load and it certainly provide a frame work for different engines manufacturers to acknowledge the best compression ratio at which the engine has to be designed.**

Keywords: **Variable compression ratio, brake thermal efficiency, volumetric efficiency, specific fuel consumption, air fuel ratio.**

I. INTRODUCTION

The compression ignition engines are widely used due to reliable operation and economy. A diesel engine is an internal combustion engine which operated using the diesel cycle. The distinguishing feature of diesel engine is that the combustion takes place when diesel is mixed with the compressed air. This compressed air helps in auto ignition and also plays a vital role in complete combustion as the atomized fuel needs oxygen to combustion. This necessary oxygen is supplied by the air. Along with compression ratios the performance of an engine is affected by the load. Therefore analyzing various parameters of engine at different loads is also crucial to optimize the engine for better performance.

II. VCR ENGINE

Compression ratio is the key parameter in reciprocating engines. The concept of variable compression ratio promises improved engine performance, efficiency and reduced emissions. The higher cylinder pressures and temperatures during the early part of combustion and small residual gas fraction owing to higher compression ratio give faster laminar flame speed. Therefore the ignition delay period is shorter. As a result at low loads the greater the compression ratio, the shorter is the combustion time. Time loss is subsequently reduced. Therefore it seems reasonable that fuel consumption rate is lower with high compression ratio at part load. The main feature of the VCR engine is to operate at different compression ratios, depending on the vehicle performance needs.

III. EXPERIMENTAL SETUP

In the present study a 5HP variable compression ratio diesel engine is chosen with variable compression ratio from 14 to 20. The air flow rate into the engine is measured by using mass flow sensor and the fuel consumption is measured by burette method. Loading is applied on the engine by help of eddy current dynamometer. The experiment is carried out at different compression ratios and different loads (0,1,2,4,6,7 kgs). The results obtained are tabulated and presented in the form of graphs.

IV. RESULTS AND DISCUSSION

TABLE I:
VARIATION OF BRAKE POWER WITH THE COMPRESSION RATIO AND
LOADS (1, 2,4,6,7 KGS)

	15	16	17	18	19
1	0.393	0.394	0..394	0.393	0.318
2	0.779	0.784	0.776	0.780	0.636
4	1.543	1.55	1.543	1.548	1.272
6	2.284	2.33	2.270	2.295	1.908
7	2.616	2.64	2.662	2.658	2.22

Compression ratio

TABLE II:
VARIATION OF SPECIFIC FUEL CONSUMPTION WITH THE COMPRESSION RATIO AND LOAD

	15	16	17	18	19
1	2.0	1.715	1.979	1.581	1.955
2	1.12	0.951	1.099	0.906	1.083
4	0.737	0.625	0.691	0.555	0.66
6	0.638	0.576	0.613	**0.472**	0.560
7	0.613	0.566	0.678	0.497	0.566

Compression ratio

Table I shows the variation of brake power with compression ratio at different loads. From the table it is observed that at a compression ratio 17 and load of 7 kg the brake power is maximum. Table 2 represents the variation of specific fuel consumption at different compression ratios and loads. From the table it is observed that at a compression ratio 18 and load of 6 kgs the specific fuel consumption is minimum.

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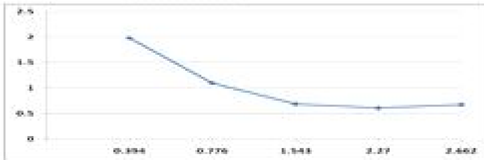
Fig.1: Variation of Specific fuel consumption with Brake Power at CR=17

Figure 1 shows the variation of specific fuel consumption with brake power at compression ratio of 17. The maximum specific fuel consumption was observed 1.979 kg/kWh at brake power of 0.394 kW .and decreases as the brake power is increases. The specific fuel consumption decreases with the increase in load and reaches minimum at 60% load. The specific fuel consumption at higher compression ratios decreases marginally. Figure 2 shows the variation of brake thermal efficiency with brake power. It is observed that with increase in brake power (load) the brake thermal efficiency increases and obtained maximum value of 13.6% at 60% load and then it starts decreasing.

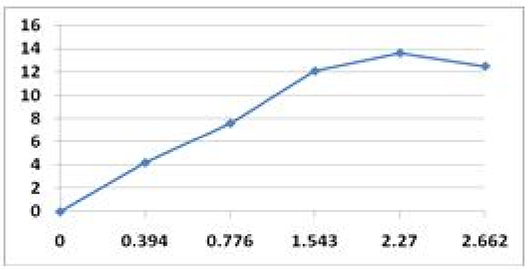

Fig.2 Variation of Brake Thermal Efficiency with Brake Power

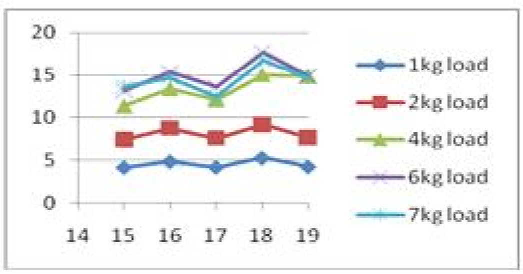

Fig.3 Variation of Brake thermal efficiency with compression ratio

Figure 3 shows the variation of brake thermal efficiency with compression ratio. It is observed that with increasing compression ratio the brake thermal efficiency increases up to certain load and then decreases. From the graph it is clear that for any compression ratio at 60% load the brake thermal efficiency reaches maximum value and then decreases. Further it is also noticed that at any load for different compression ratios the brake thermal efficiency is maximum at compression ratio 18.

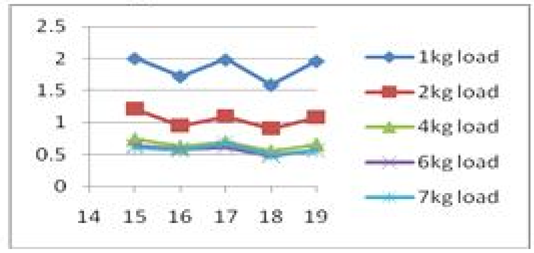

Fig.4 Variation of Specific fuel consumption with compression ratio

The fuel consumption characteristics of an IC engine are generally expressed in terms of specific fuel consumption (kg/kWh) which is an important parameter that reflects how good the engine performance is. Figure 4 shows the variation of specific fuel consumption with compression ratio at different loads. From the graph it is observed that at any load the specific fuel consumption is minimum at compression ratio 18.

CONCLUSIONS

In the current study an attempt is made to find an optimum compression ratio for diesel engine with diesel oil. With respect to brake power the optimum compression ratio was found as 17. But with respect to brake thermal efficiency and specific fuel consumption the optimum compression ratio is found to be 18. Therefore it is understood that the optimum compression ratio for the current diesel engine will be around 17.5. The volumetric efficiency of the diesel engine is varies by 1% with different compression ratios. The air fuel ratio of the engine is in the range of 45:1 to 15:1 between the compression ratios 15 to 19.

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